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REVIEW ARTICLE

Influence of Stretching & Icing In Neurological Conditions to Relieve Spasticity - A Systematic Review

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ABSTRACT:

Background: Spasticity is a consequence of neuromuscular disorders, which affects quality of life in those who experience this phenomenon. Spasticity results from an upper motor neuron lesion that disinhibits the tendon stretch reflex; spasticity results in a velocity dependent tightness of muscle. Icing inhibits the proprioceptive afferent pathways responsible for the transmission of information to the spinal cord and the thalamus. Where in muscle influence the excitability in spinal cord to decrease spasticity. This could be suggested as one of the mechanisms of relieving spasticity by cold therapy. Stretching suppresses monosynaptic spinal reflex excitability in stretched muscles also included as part of a training and recovery and improves flexibility and range of motion of joints. **Objective:** To investigate the literature evidence for the effect of stretching and icing on spasticity in neurological conditions. **Methodology:** Review contain latest literature, studies included within last 20 years. They were entered into PubMed, Google scholar and Ovid databases, which included Medline, CINAHL, and Journals at Ovid full text, EBM reviews. The population which was selected were adults and children with spasticity developed after neurological conditions. A systematic literature search was evaluated 50 articles related to effect of stretching & icing on spasticity. Out of 50 articles we selected, 40 articles which were found suitable for reviewing the effect of stretching and icing on spasticity in patients with neurological conditions. Studies written in English language were only included. **Conclusion:** Stretching helps in reducing the contracture and prolonged muscle stretch reduces the motor neuron excitability. The study as well suggested that icing applied to the spastic muscles is effective in decreasing muscle tonus level, but indicating short term benefits in the context of clinical practice. There is also hypersensitivity reactions to cold were observed.

Key words: Cryotherapy/ Cold therapy/Icing, Stretching, Spasticity, Physical therapy.

Introduction:

Spasticity is a primary disabling symptom in many patients with neurological conditions (stroke, multiple sclerosis, spinal cord injury, traumatic brain injury and other central nervous system lesions). During functional movements, spasticity manifests itself within the complex condition of the "spastic movement disorder"[1]. In spasticity, the faster the muscle is stretched, the greater is the resistance. Spasticity leads to impairment of function and limitation of activity[2]. The descending motor pathways' lesions cause an imbalance in neural activity, which leads to positive and negative phenomena. Spasticity is a positive phenomenon and develops in upper motor neuron syndromes such as stroke, brain injury and multiple sclerosis[3].

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The physical features of spasticity are mainly pain, involuntary movements, abnormal postures, and resistance to movement, leading to secondary problems such as change in muscle length, which causes the development of contractures and deformity[4]. Spasticity results from an alteration in the balance of inputs from reticulospinal and other descending pathways to the spinal cord's motor and inter-neural circuits. When the muscle is stretched, the primary afferent fibres that supply the intrafusal fibres of the muscle spindle gets excited, and this triggers the monosynaptic excitatory connection with the α motor neuron, which supply the stretched muscle and results in contraction of the stretched muscle and excitatory connections with α motor neuron that supplies the synergistic muscle. The afferent fibres have a monosynaptic connection with a spinal interneuron that inhibits the antagonist's muscle. This controlled contraction of the agonist and reciprocal inhibition of the antagonist's muscle is impaired in upper motor neuron syndrome[4]. Spasticity is considered an important symptom that can restrict a patient's functional abilities and reduce their quality of life. When it affects the lower limbs, spasticity may have adverse effects on balance, mobility, and gait. It may also increase the risk of falls and fractures in people who have experienced a stroke[5].

Spasticity and its management are the major problems in rehabilitation. There are three major approaches in the management of spasticity and currently used are pharmacological, surgical and physical therapy. Physical therapy remains the most practical form of treatment; the treatment includes stretching, passive range of motion, myofascial release, Vibratory stimulation, icing and inhibitory techniques etc.[6] Stretching is the process of elongation and mainly used to reduce spasticity. Stretching leads to an increase in soft tissues' extensibility by a mechanism that involves viscous deformation and structural adaptions of muscles and soft tissues. The structures under tension are muscle, tendon, connective tissues and vascular, dermal and neural tissue. Stretching aims to normalize the tone, reduce the pain, increase the soft tissue extensibility, and improve function[7]. The stretching technique can be given in various forms, which includes - passive stretching, active stretching, prolonged stretching, ballistic stretching, isokinetic stretching and isotonic stretching and also in multiple ways depending upon the intensity of the stretch, that is, the amount of tension that can be applied to the structure which can keep constant or can be varied[8].

Stretching leads to decreased stiffness, improves movement control, increases motor neuron excitability, decreases contracture development, increases range of motion, enhances gait pattern, and reduces energy during walking9. Children depend upon various factors such as the age of the child, the severity of spasticity and contracture, tolerance of the stretch, cognitive level of the child and functional outcomes of the child depending upon its Gross motor function classification score[10]. According to Song Jun et al., they studied the effect of hand stretching device to reduce spasticity in chronic hemiparetic stroke patients. They used a resting hand splint and hand and finger stretcher as a stretching device, and the outcome measure used was the modified Ashworth scale. So, they found that stretching device effectively reduces hand spasticity in patients with chronic hemiparetic stroke[11].

Icing is broadly used as a medicinal treatment, and this strategy is used in the management of different acute and chronic conditions. Cold therapy can facilitate muscle contraction and can be used to improve muscle contraction to increase joint motion after an injury. Icing can facilitate muscle contraction and can be used to improve muscle contraction to increase joint motion after an injury.

Icing can facilitate muscle contraction and can be used to improve muscle contraction to increase joint motion after an injury. Another cold therapy impact is a period - related spasticity decrease once the ice has been applied for a long time. Icing can be applied to the body in three ways: submerge the part in cold water, scour ice cubes or ice packs, or use evaporative sprays like ethyl chloride[12]. Icing is frequently used to inhibit spasticity, which has been previously studied by applying different measurements that show contradictory results[13].

Michlovitz- stated that inhibition occurring due to icing might be due to the local cooling effect on every component of the segmental sensorimotor complex, including large afferent fibres of muscle spindle (both alpha and gamma motor neurons)[14]. Icing is commonly used to inhibit spasticity, which has been previously studied by applying different measurements that show contradictory results[15].

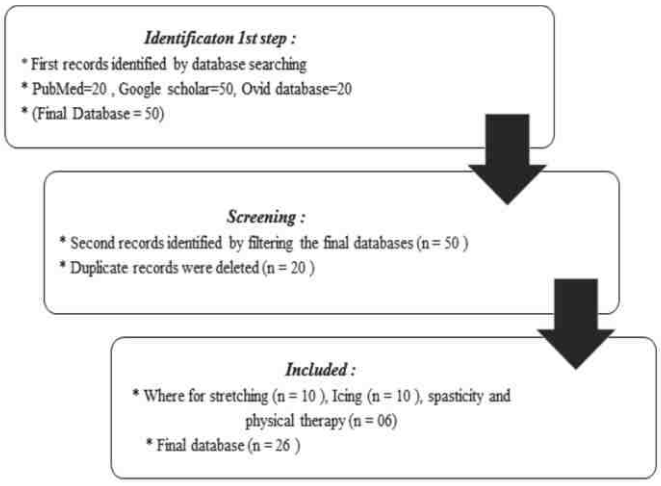
Literature reports that icing temporarily decreases spasticity, as well as deep tendon reflexes and clonus, due to decreased sensitivity of skin mechanoreceptors, slowed transmission of sensory and motor nerve fibres (alpha) or the decrease in the sensitivity to stretching of the neuromuscular spindle (NMH) and consequently, of the activity of the gamma system[16,17].

According to some authors and studies, it is stated that stretching followed by passive exercise reduces hyperactive stretch reflexes, slowly sustained stretch helps in reducing the contracture and prolonged muscle stretch reduces the motor neuron excitability. The intervention to decrease spasticity is widely varied with the aims and possibilities. On the other hand, the icing has proved to have a positive result in reducing spasticity as the nerve fires the impulses that reduce the spasticity. This study aims to find the effectiveness of stretching and icing on spasticity in patients with neurological conditions.

METHODOLOGY

A systematic review was undertaken of all literature concerning the effect of stretching to reduce spasticity. The keywords like Stretching, Icing and spasticity were entered into PubMed, Google Scholar, Science Direct, Cochrane Library. The electronic search was done by cross-checking the references list of all relevant articles. We covered all the documents available on these sources. We took only those articles which were present in the English language. We used the following indexing and text terms to search the data: cryotherapy or cold therapy or icing, spasticity, stretching and physical therapy.

The Selection Criteria were: Articles were referred for the icing, stretching, and spasticity also physical therapy. The review contains literature, only studies included within the last 30 years. Studies written in the English language were included.



Result Analysis

SUMMARY OF EXPERIMENTAL STUDIES:

Sr. no	Study	Design	Subjects and treatment	Outcome Measures	Results / Conclusions
1	Luccas Cavalcanti Garcia et. al. (2019)	RCT	16 chronic hemiparetic patients. Group 1 receive cryotherapy for 20 minutes on calf muscles; Group 2 received conventional therapy.	A Biodex Multi-joint System 3 dynamometer, MAS	Cryotherapy temporarily reduces the degree of spasticity in the leg muscles in chronic hemiparetic stroke patients. The efficacy of cryotherapy in reducing spasticity without affecting proprioception.
2	Carolina Carmona Alcantara et. al. (2019)	RCT	16 chronic hemiparetic subjects. Spasticity levels between 1 and 3 according to MAS on the ankle flexor muscles.	1) Modified Ashworth Scale; 2) isokinetic dynamometer 3) tri-dimensional movement analysis system.	This study suggested that cryotherapy applied to the calf muscles of subjects with chronic hemiparesis reduces muscle hypertonia but does not improve dorsiflexion and plantar flexors performance and gait parameters.
3	Elanchezhian Ch, Swarnakumari P. et al 2019	Comparativ experimenta l	Twenty subjects in the conventional group were given regular conventional training and 20 subjects in the experimental group were given cold therapy, passive stretching in both legs before training.	Modified Ashworth scales were used to measure spasticity. The gait parameters were measured, and the Timed Up and Go test (TUG) was used to measure the functional activity.	A significant effect was observed in a decrease in spasticity. The study concluded there was decreased tone in spastic muscles and improvement in gait parameters and functional ability in children with diplegic
4	Barkha Khurana et al. 2018	Comparativ e experimenta l	40 patients with chronic head injury (aged 25-50 yrs.) Group A- Quick icing for 10 min on antagonist muscle Group B – Prolonged stretch	Modified Ashworth Scales(MAS)	The authors concluded that prolonged sustained stretching has a significant impact on the reduction of tone according to the modified Ashworth scale; the sustained extension on spastic agonist muscle is superior to quick icing on the antagonist's muscle.
5	Urvashi Bhattacharya et al. 2017	RCT	94 cerebral palsy patients. Treatment Intervention group- MFR on calf muscle Control group – Passive stretching was given.	Modified Ashworth Scales, GMFM ROM of ankle dorsiflexion	The authors concluded that passive stretching was found to be more effective than MFR
6	Mayerly C. Anaya N. et. al. (2016)	RCT	Fifteen subjects with spastic hemiparesis. Treatment:: Experimental Group received an application of Ice Pack in cubes on the plantar flexors for 20 minutes, and the Control Group remained at rest. Prone	Skin temperature, degree of resistance of the plantar muscles to passive movement and Reflex H parameters: latency and normalized amplitude index Hmax / Mmax (%).	The study concluded that twenty minutes of icing on the calf muscles are helpful in a temporary decrease of spasticity.

SUMMARY OF EXPERIMENTAL STUDIES:

7	Jang et al. 2016	RCT	21- Chronic hemiparetic stroke patients Treatment-IG- Wrist and hand stretching device was used to give stretching, one session for performed for 14 minutes. CG treatment was not given.	MAS, Fugl Meyer motor assessment scale, AROM	The author concluded that this stretching device is effective in spasticity reducing and motor function improvement
8	Anaya MC et al. 2016	Systematic review	Effects of different cooling applications, compared to non-cooling, passive post-exercise strategies, on recovery characteristics. A total of n = 36 articles were processed in this study.	Meta-analyses of subjective characteristics, such as delayed-onset muscle soreness (DOMS)	There was no evidence that cooling affects the objective recovery variable significantly during a 96 hrs recovery period.
9	Dr. Shrikant Darade (2015)	Experimental study	Total 30 participants who are hemiplegic patients with plantar flexor spasticity and walk Treatment- Ice cube was taken in a turkey towel, exposing one surface, and stroked over gastro soleus slowly from origin to insertion, maintaining a continuous and direct contact for 30 minute	Modified Ashworth Scale, Goniometry and velocity formula	It is concluded that icing decreases spasticity and increases the ankle's range of motion by improving gait velocity.
10	Larsan, CC, Troiano et al (2015)	Within-group experimental group	15 subjects underwent three treatment conditions: Crushed ice bag, wetted ice bag and no ice bag. Subjects hamstring ROM was measured at baseline then again after 20 min icing treatment session.	Range of motion	The study indicates that strength and conditioning specialists can increase ROM with both forms of ice combined with PNF stretching.
11	Jolanta Krukowska et .al. (2014)	An Experimental study	Fifty-six patients with post-stroke spasticity. Group 1 was administered cryotherapy and Exercises, and Group 2- Exercises only	Modified Ashworth Scale, Brunnström Scale	A decrease in spasticity and improved limb function indicate a stabilization of muscular tension in patients with disorders upper motor neuron.

SUMMARY OF EXPERIMENTAL STUDIES:

20	Yeh et al. 2004	Single group pre-test- post-test	Twenty-five patients with spastic hemiplegia were included. Treatment- Ankle plantar flexors stretched in one session for 30 minutes was given	MAS, ROM	They concluded that spasticity was reduced & showed significant improvement in PROM by cyclic stretching.
21	Bressel and McNair et al. 2002	RCT	Two treatments compared: 1. Continuous passive motion; 2. Prolonged static stretch	Ankle torque: Electromyographic activity of tibialis anterior and lateral gastrocnemius	Ankle joint stiffness decreased by 35% and 30% after static and cyclic stretch, respectively. Between-group difference not significant.
22	Zhang et al. 2002	Nonrandomized clinical trial.	Intelligent feedback-controlled ankle stretching device, Movement velocity inversely proportional to the resistance torque	Passive and active ROM, Tendon reflex characteristics, Torque-angle relationship	Ankle stiffness, viscosity, and reflex excitability decreased significantly; Passive ROM increased significantly, clonus disappeared
23	Hui-Yi Chang et al. 2001	single group experimental study	17 patients of Spastic Hemiplegia Treatment- Prolonged muscle stretch to triceps surae muscle was for 30 minutes	MAS H/M ratio of triceps surae, F/M ratio of TA PROM of ankle dorsiflexion	The result showed that passive ROM was increased significantly & 30 minutes of Prolonged muscle stretch was effective in reducing motor neuron
24	Harvey et al. 2000	RCT	14 SCI subjects with paraplegia and quadriplegia were included. Treatment- Ankle was stretched into dorsiflexion for 30 minutes per day for four weeks	Passive ROM	The authors concluded that stretching is an effective measure to reduce spasticity in patients with spinal cord injury
25	N. Hassan et al. 1995	Single group experimental study	Sixteen patients with mild to moderate spasticity in stroke patients. Treatment- Prolonged mechanical stretch to the biceps muscle	MAS EMG-Amplitude	The authors suggested that sustained stretch is a beneficial and practical method to reduce muscle tone in patients with spastic arm muscles.
26	Hale et al. 1995	RCT	Twenty-three patients with stroke, 2 with a head injury and one patient with multiple sclerosis with spasticity of one or both quadriceps muscles were included. Treatment- Prolonged muscle stretch was given. The mechanical stretch was given to	MAS Knee flexion & extension performance test Pendulum test with Cybex.	

DISCUSSION

This systematic review predominantly shows the effect of stretching and icing on spasticity in neurological conditions. Some studies show the effect of stretching on spasticity and the effect of icing on spasticity. There is diversity at various levels such as in methodology, population, intervention, outcome measure. Physical therapists commonly use stretching to reduce spasticity and improve motor functions in patients with neurological conditions. Icing is also a widely used physical therapist's interventions to reduce spasticity in patients with neurological conditions. As many stretching techniques have been proposed and the stretching's general features, mainly intensity, should be carefully examined, including the duration, repetition, and frequency. We aimed to investigate the effect of stretching and icing to relieve spasticity in neurological conditions.

Studies reported that the upper limb's degraded function in patients with neurological conditions had shown a significant correlation with the decrease in proprioceptors, contracture of muscles, subluxation of the shoulder, increased shoulder pain, and peripheral tissues the shoulder joint that showed lesion under ultrasonography. Furthermore, the study reported that 30 min of static stretching of immobilized muscle improved sarcomeres' mobility correspondingly if static stretching is applied for 30 mins for four times a week can prevent contracture of joints. The study done by Yeh et al. 2001 on the effect of a single session of prolonged muscle stretch on the spastic muscle of stroke patients showed that there was a significant increase in the ROM of ankle dorsiflexion after 30 minutes of prolonged muscle stretching. It occurs due to the motor neuron excitability of the triceps surae muscle decreased after a prolonged muscle stretch. There were changes seen in the H reflex values due to the Ib afferent fibres in this case; the Golgi tendon organ was fired while stretching the calf muscle. Then, the Ib afferent fibre transmitted the impulse through the interneuron; thus, inhibiting the α motor neuron. Another reason was may be due to the II afferent fibre, in this case, the muscle spindle of the calf muscle was fired during the muscle was being stretched, which in turn causes the impulse to get transmitted by the II afferent fibre through the spinal cord, thus, inhibiting the neuron excitability of α motor neuron[19]. Bakheit et al. compared the impact of a single session of isokinetic or isotonic muscle stretch on gait in patients with spastic hemiparesis. They measure α motor neuron excitability by measuring the latency in the H-reflex and then the ratio of the amplitude of the maximum H-reflex to that of the maximum action motor potential of the soleus spastic muscles. They concluded that muscle stretching reduces spasticity by neurophysiological mechanisms rather than the direct effect on the excitability of α motor neuron[9]. According to Ana Paula Salazar et al. 2018, there was low-quality evidence that static stretching by simple positioning is not better than conventional physiotherapy for preventing loss of mobility. receptors or the afferent fibres themselves.

Lehman did the study, and de lateur et al. reported that ice application had been found useful to reduce spasticity in upper motor neuron lesion and in muscle re-education to facilitate muscle contraction. Similarly, Lin et al. found that ice can facilitate increasing the range of motion of joint. Furthermore, Lehman et al. reported that in the management of spasticity, ice application can decrease tendon reflex excitability and clonus, increase the joints' range of motion, and improve the antagonist muscle group's power. The study was done by Urbscheit et al., who investigated H-response changes and the Achilles tendon jerk in hemiplegic patients after ice application.The study was done by Urbscheit et al., who investigated H-response changes and the Achilles tendon jerk in hemiplegic patients after ice application.

The author suggested that local cooling might decrease, increase, or exert no effect on spasticity [17]. This study's results support the findings of Warren et al., who concluded that deep prolonged and penetrating cold could be used in therapy to induce relaxation. They attributed their findings to be due to the lowering of the background level of stretch afferent input. They reported that deep cold produces a cold block of the receptors or the afferent fibres themselves.

Similarly, Price et al. on the effect of cryotherapy on spasticity at the human ankle support our results. They established that cryotherapy reduces the path length, a parameter indicating the frequency-dependent viscoelastic response at the ankle. High values of path length are associated with the presence of spasticity. They recommended the use of cryotherapy for one h on the calf muscles aiming for spasticity reduction 18. Along with all the above-mentioned studies, Gehan M. Abd El-Maksoud et al. 2011 provided evidence that the combination of icing and stretching can reduce spasticity and translate into practical, functional gains in patients with neurological conditions.

Stretching followed by passive exercise reduces hyperactive stretch reflexes, slowly sustained stretch helps reduce the contracture, and prolonged muscle stretch reduces the motor neuron excitability. On the other hand, the icing has proved to positively result in reducing spasticity as the nerve fires the impulses that reduce the spasticity. After reviewing all these studies presented on stretching and icing, we have found that patient characteristics widely vary between and within all the studies. It all depends upon the neurological condition, nature, the severity of the spasticity; it also depends upon the pathophysiology of the icing, stretching, and spasticity, whether it originates from the spinal or brain level and, according to it, the effect of icing and stretching varies.

CONCLUSION

This study includes a wide variety at the level of methodology, population, and intervention also outcome measure. Studies that supported together icing and stretching through physical therapy have shown better results on patients with neurological conditions. Stretching helps in reducing the contracture, and prolonged muscle stretch reduces the motor neuron excitability. The study also suggested that icing applied to the spastic muscles effectively decreases muscle tonus level but indicates short-term benefits in clinical practice. There is also hypersensitivity reactions to icing were observed.

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CONFLICT OF INTEREST:

None Reported

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